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КОМП’ЮТЕРНІ НАУКИ ТА ІНФОРМАТИКА

УДК 519.63

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Розв'язок задачі Коші та крайової задачі для рівняння третього порядку з дискретними адитивно-мультиплікативно-поверативними похідними

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Solution of Cauchy and boundary problems for the third compilation discrete additive-multiplicative-powerative derivative equation

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Відомо, що дослідження розв'язків задачі Коші та крайової задачі для рівнянь з дискретними похідними достатньо багато. Також раніше розглядалися деякі питання для рівнянь з дискретними мультиплікативними похідними. В статті розглядається задача Коші та крайова задача для вищезгаданих дискретних рівнянь з поверативними похідними як продовження дискретних похідних. Слід відмітити, що рівняння з дискретно-мультиплікативними похідними нелінійні. Але рівняння з дискретно- адитивними похідними лінійні.

Ключові слова: дискретна адитивна похідна, дискретна мультиплікативна похідна, дискретна поверативна похідна, задача Коші, крайова задача.

It is known that just enough investigated solution of Cauchy and boundary problems for discrete derivative equations. It is known that solution of the Cauchy and boundary value problems for the fractional derivative equations are well investigated. Also some problems were considered for the discrete multiplicative derivative equations. Here we consider the Cauchy and boundary value problems for the above mentioned fractional powerative derivative equations as a continuation of the fractional derivatives. We should note, that these equations are non-linear as a fractional multiplicative derivative. But fractional additive derivative equations are linear.

Key words: discrete additive derivative, discrete multiplicative derivative, discrete powerative derivative, Cauchy problem, boundary problem.

Статтю представив д.ф.-м.н. Хусаінов Д.Я.

I. INTRODUCTION

It is well-known that the event sometimes is discrete itself. For example, the mathematical model of the rabbit breeding procedure leads to the Fibonacci sequence formulation [1]. In the same way, the general set of the numerical sequence is also a discrete model [2]. These models are provided with discrete additive derivatives. The general theory of these could be found in the following literature [3] - [5].

Multiplicative derivative and an uninterrupted form and the simple properties of integral are given as uninterrupted form 3 on page 4, [6] When we become a discrete multiplication, we can illustrate the problem of establishing the general limit of the series [2].

The issues for discrete-multiplicative-additive and multiplicative-additive derivative equations were considered in [7] - [9].

As for a derivative powerative it is worth noting that it is necessary to make a new deed in order to illustrate it in the uninterrupted form. Do not to avoid these difficulties to these desires we talk about a discrete powerative derivative. It is enough to sum this with one inverse algebraic root deed [10].

In the case of theoretical investigation of the issues considered in modern mathematics, the issues are discrete for ordinary or special derivative equations and it is possible to state a certain judgment on solution of a discrete problem as the obtaining system of the linear algebraic equations are solved, the chosen step is approximated by zero, [11] - [13].

II. DEFINITION

Let's look at the following equation as:

$$\left(\left(y_n^{(I)}\right)^{[I]}\right)^{\{I\}} = f_n,\ n \geq 0, \tag{1}$$

Here $\{f_n\}$, n≥ 0 given sequence, $\{y_n\}$, $n \geq 0$ is the desired sequence.

By using the definition of the discrete additive, multiplicative and powerative derivatives:

$$y_n^{(I)} = y_{n+1} - y_n,$$

$$\left(y_n^{(I)}\right)^{[I]} = (y_{n+1} - y_n)^{[I]} = \frac{y_{n+2} - y_{n+1}}{y_{n+1} - y_n},$$

$$\left(\left(y_n^{(I)}\right)^{[I]}\right)^{\{I\}} = \left(\frac{y_{n+2} - y_{n+1}}{y_{n+1} - y_n}\right)^{\{I\}} =$$

$$= \sqrt[\frac{y_{n+2} - y_{n+1}}{y_{n+1} - y_n}]{\frac{y_{n+3} - y_{n+2}}{y_{n+2} - y_{n+1}}},$$

It then falls below (1):

$$y_{n+3} = y_{n+2} + (y_{n+2} - y_{n+1}) f_n^{\frac{y_{n+2} - y_{n+1}}{y_{n+1} - y_n}}, \tag{2}$$

$$n \geq 0.$$

Here, if accept: n=0

$$y_3 = y_2 + (y_2 - y_1)\, f_0^{\frac{y_2 - y_1}{y_1 - y_0}}, \tag{3}$$

If we take n = 1 in the statement (2), then we must:

$$y_4 = y_3 + (y_3 - y_2)\, f_1^{\frac{y_3 - y_2}{y_2 - y_1}}. \tag{4}$$

By continuing this process all y_n (n≥ 3), we can assign trough y_0, y_1 and y_2.

III. CAUCHY PROBLEM

Thus, as seen from (3) and (4), if

$$y_0 = \alpha_0,\ y_1 = \alpha_1,\ y_2 = \alpha_2, \tag{5}$$

if we accept the terms, I mean (1) for equation look at **Cauchy problem** , we obtained:

$$y_3 = \alpha_2 + (\alpha_2 - \alpha_1)\, f_0^{\frac{\alpha_2 - \alpha_1}{\alpha_1 - \alpha_0}}, \tag{6_1}$$

$$y_4 = y_3 + (y_3 - \alpha_2)\, f_1^{\frac{y_3 - \alpha_2}{\alpha_2 - \alpha_1}}. \tag{6_2}$$

Here in the form of y_3 (6_1). So we have it:

Theorem 1. If the given affirmatively extent sequences f_n n≥0, α_k k=$\overline{0,2}$ as the given with constants $\alpha_0 \neq \alpha_1$, and $\alpha_1 \neq \alpha_2$ then, (1), (5) there is unique solution of Cauchy problem, and this solution continuously receives through (2). It is obvious from (6_1) that if, $\alpha_0 \neq \alpha_1$ and $\alpha_1 \neq \alpha_2$, then $y_3 \neq \alpha_2$ or $y_2 \neq y_3$. By the same rule (6_2) it appears that $y_3 \neq y_4$. If we continue this process, ∀ n∈N is $y_n \neq y_{n+1}$. Therefore, the solution (1), (5) can be taken from (2).

Now let's try to get a general solution of the equation (1). To do this, we use the definition of a discrete powerative derivative:

$$\sqrt[\left(y_n^{(I)}\right)^{[I]}]{\left(y_{n+1}^{(I)}\right)^{[I]}} = f_n,\ n \geq 0, \tag{7}$$

from here also

$$\left(y_{n+1}^{(I)}\right)^{[I]} = f_n^{\left(y_n^{(I)}\right)^{[I]}},\ n \geq 0. \tag{8}$$